this procedure only after conservative measures of pain control have been completely exhausted. In addition, patients who are overweight should lose excess weight and participate in a spine muscle strengthening and flexibility program before being considered as candidates for a fusion procedure. In a certain number of well-motivated patients, dedicated efforts directed at weight control, muscle strengthening, and maintenance of proper spinal alignment and body mechanics can obviate the need for a large surgical procedure. In the right patients, however, a fusion procedure for mechanical instability of the lumbar spine can make the difference between disability and a meaningful life.

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Implantable Neurosurgical Drug Delivery Systems

IMPLANTABLE NEUROSURGICAL DEVICES provide an elegant and novel means of delivering drugs to the central nervous system. They have had increasing applications in the management of intractable pain, certain neurologic disorders, and malignant lesions and infections of the central nervous system.

The epidural, subarachnoid, or intraventricular administration of medication represents an effective approach to the delivery of drugs to a specific site within the central nervous system. This approach provides for a controlled, direct, and precise delivery of drugs. The identification of opiate receptors in the central nervous system stimulated the development of a method assuring the direct delivery of synthetic and semisynthetic opioids to the brain and spinal cord. By circumventing the blood-brain barrier, smaller dosages of medication are feasible and systemic side effects are minimized.

Implantable devices consisting of reservoirs and pumps are gaining increasing favor in neurosurgical practice. The surgical implantation of such devices is reasonably safe and easy. Catheters are placed in either the spinal epidural space or the subarachnoid space through a small skin incision or inside the cerebral ventricles through a small twist-drill hole. These catheters are then tunneled subcutaneously and connected to an infusion pump that is placed in a subcutaneous pocket, generally in the abdomen, flank, or chest. Such a closed system provides the advantages of long-term, controlled, sustained delivery of medication with minimal inconvenience and risk of infection.

Rapid technologic advances have provided sophisticated delivery systems. Large reservoirs filled percutaneously and placed remote from the delivery sites permit conveniently long intervals between drug refills, thereby minimizing the risk of infection, discomfort, and other complications. Remote programmable pumps permit changes in drug dosage by telemetry.

The use of such systems has seen increasing acceptance in the treatment of intractable cancer pain, otherwise difficult to control by oral or parenteral medication. Lumbar or cervical spinal catheter placement is used for the treatment of truncal pain. The intraventricular administration of opioids is effective for head and neck pain. The use of such opioid drug delivery systems for chronic pain of benign origin has been attempted in certain centers, but such application remains controversial. Furthermore, because these systems are expensive, they probably are not justified for short-term use.

Similar drug delivery systems have been used to good advantage in the treatment of malignant tumors and infections of the central nervous system. The intrathecal administration of baclofen for spasticity has received recent attention. Other neurologic disorders undoubtedly will be treated in a similar manner.

The long-term use of implantable drug delivery systems can result in a number of complications. Blocked or migrating catheters and pump failure are easily recognized and generally readily corrected. The development of drug tolerance is a more serious problem. Although this often represents a "pseudotolerance" resulting from a mechanical system failure, such tolerance to opioid medications may occur with long-term use. Generally drug tolerance develops more slowly with continuous spinal infusion than with bolus administration. The problem may be overcome initially by increasing the concentration or substituting another opioid. In intractable cases, however, narcotic detoxification may be necessary.

The direct delivery of medication to the central nervous system using implantable devices assures a controlled, sustained, convenient, and long-term administration of effective medication without compromising normal neurologic function and with minimal systemic side effects. This method should not be construed as a panacea. Proper patient selection is essential. Advancing technology offers an exciting prospect for benefiting future generations of patients through neurosurgical care.

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Interstitial Radiotherapy for Malignant Glioma

CURRENT THERAPY FOR MALIGNANT GLIOMA consisting of surgical resection, external-beam radiotherapy, and carmustine (BCNU) chemotherapy can prolong survival, but the overall prognosis remains poor. Most patients have significant tumor progression within the first two years after their initial treatment.

While the efficacy of external-beam radiotherapy in controlling residual tumor following surgical resection has been well established, increasing doses of radiation are associated with increasing toxicity to the surrounding brain. One strategy to deliver additional radiotherapy to the tumor has been to give a "boost" of radiation by implanting radioactive sources into the tumor bed. The theoretic advantages of such "seed implants" include a relatively high overall dose of radiation to the tumor with relatively low exposure to surrounding brain. Another possible advantage of tempo-